GEOG 3511 HYDROLOGY
Review for Second Midterm

The second midterm will be similar to the first one: several fill-in-the-blank questions, several short-answer questions, plus this time I will have you do a calculation. I realize that I have given you a lot of equations. Focus only on the equations discussed in class and make sure you understand the following things:

- what is the equation used for, or why is one equation used instead of another?
- what are the various terms in the equation, and what do they represent physically?
- what field data are needed to use a particular equation?

You don't need to memorize any complex equations; however, you should know simple equations, such as those for SWE, relative humidity, moisture content, bulk density, or porosity. I will provide the more complex equations and either ask you what the terms represent, or ask you to calculate something. Otherwise focus on the following information:

Snow

- you should be able to describe the processes/conditions of snow formation in the atmosphere and explain how measurements are made on the ground;
- know the processes of snow metamorphism (equi-temp vs. temp-gradient metamorph.);
- you should be able to describe seasonal changes in snow properties such as density & SWE
- understand the basic components of the snowmelt energy balance, and be able to describe how certain environmental conditions (aspect, tree cover, relative humidity, etc.) affect various terms; know what the various terms in the turbulent transfer equations represent; you should be able to do a latent- or sensible- heat flux calculation, similar to the one we did in class; make sure you understand the relation between SVP, temp. and rel. humidity.
- review the lecture notes on seasonal variations in snow-energy balance, and the case studies from Danville, VT and Niwot Ridge. Under what conditions does snowmelt reach maximum rates?
- review notes on changes in the timing of snowmelt and changes in snow cover.

Soil Moisture:

- you should be able to define various soil properties, such as bulk density, porosity and hydraulic conductivity, and describe the various soil moisture states, such as saturation, field capacity and wilting point.
- you should be able to describe the process of infiltration, and explain how certain variables, such capillary tension and hydraulic conductivity, vary throughout a rainstorm.
- I did not do a particularly good job explaining the Green-Ampt model of infiltration; however, you should be able to understand the resulting equation,

$$i = K_{sat} \quad \frac{{}_f\left({}_s \quad {}_o\right)}{I} + 1$$

where i is the infiltration rate, K_{sat} is the saturated hydraulic conductivity, ${}_f$ is the tension at the wetting front, ${}_s$ is the saturated moisture content, ${}_o$ is the initial moisture content and I is the cumulative depth of infiltration.

Additional thoughts:

- we have used three different terms for vapor pressure; these are defined as follows
  - e_a: vapor pressure at some height above the surface;
  - e_s: vapor pressure at the surface;
  - e_{sat}: saturation vapor pressure = vapor pressure at 100% relative humidity, *r*; this could be measured with respect to the reference height z = a or the surface;

- example: the turbulent transfer equation for latent heat flux contains the term (e_a - e_s). To find either of these two terms, you need to know *r*, and you need be able to compute e_{sat}, using the equation for saturation vapor pressure,

$$e_{sat} = 6.11\exp\frac{17.5 \text{ x } T}{241 + \mathrm{T}}$$

I will give you this equation, but you need to know how to apply it.

- The other equation involved in turbulent transfer relations is the logarithmic equation for velocity:

$$u(z) = u_* \frac{1}{\;} \ln \frac{z}{z_o}$$

where *u(z)* is the velocity at height z , u_* is the shear velocity,   is von Karman's constant (0.4) and z_o is the roughness height. The term u_* has the units of velocity, but it is really a measure of the shear stress (force per unit area) that is driving the air to create the wind in the first place; u_* is also a measure of turbulence intensity, so if u_* goes up, the turbulence will be more intense and more heat will be transferred between the atmosphere and the surface. The term z_o is theoretically the height above the surface where the velocity is zero; in practice this is impossible to measure because it is usually a fraction (~1/10) of the height of the roughness itself. Note that as the surface roughness increases, z_o gets bigger, and, for the same u_*, u gets smaller.